

TCE Alternatives Project

Minnesota Technical Assistance Program

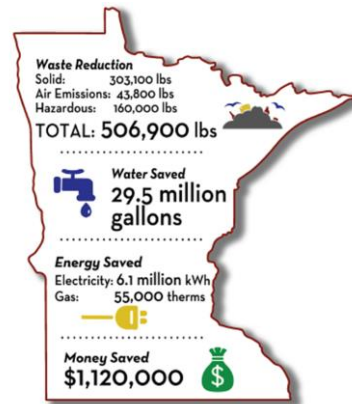
Jane Paulson
Iowa Strategic Goals Program
Presentation
March 23, 2021



UNIVERSITY OF MINNESOTA
Driven to DiscoverSM

Minnesota Technical Assistance Program - MnTAP

- Strengthening Minnesota businesses by improving efficiency while saving money through energy, water, and waste prevention.
- Eliminate hazards, wastes and resource use at the source
 - Pollution Prevention
 - Energy Efficiency
 - Water Conservation
- Engineering technical assistance for Minnesota businesses
 - Confidential
 - No cost
 - Non-regulatory
- <http://www.mntap.umn.edu>



Where to get help in Iowa?

- **Iowa Waste Reduction Center - University of Northern Iowa**
 - Small businesses 100 employees or less
 - iwrc.uni.edu
- **Iowa DNR - Pollution Prevention Services**
 - Business with 100+ employees
 - www.iowap2services.com



Spotlight on TCE in Minnesota



MPR
news

Water Gremlin to pay \$500 fine per day in addition to \$7 million settlement



White Bear
Press
Thursday, October 31, 2019

Neighbors still keeping watch over Water Gremlin



ChemicalWatch
GLOBAL RISK & REGULATION NEWS

[Minnesota legislators consider trichloroethylene ban](#)



4
WCCO

CBS Minnesota

Water Gremlin to pay \$500 fine per day in addition to \$7 million settlement



EDF
ENVIRONMENTAL
DEFENSE FUND
Finding the ways that work

Over 200 People from Communities Impacted by Toxic Chemical Demand EPA Take Action
Residents urge EPA to ban high-risk uses of trichloroethylene (TCE) to safeguard public health



**Mn
TAP**

UNIVERSITY OF MINNESOTA

What is Trichloroethylene (TCE)?

Pros

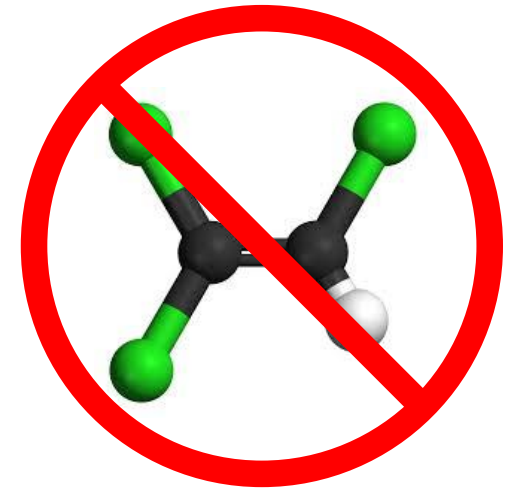
- Clear **non-flammable** liquid with a slight sweet smell
- Evaporates at moderate temperatures
- Dissolves a large number of materials – greases, oils, plastics
- **Low cost** and familiar to industry



Cons

- Known human **carcinogen**
- Can affect the liver, kidneys, immune, reproductive, and central nervous systems
- May affect fetal development
- Highly **regulated**
- Increased MPCA scrutiny
- Heightened public awareness

Minnesota TCE Ban



- **1st statewide ban in the nation passed May 2020**
- **Applies to facilities with state-issued air permits**
- **Effective June 1, 2022**
 - Extension to June 1, 2023 available for small businesses (<500 employees)
 - Must demonstrate compliance with HBV of 2 $\mu\text{g}/\text{m}^3$ and health risk limits for TCE
- **Includes manufacturing, processing, cleaning processes**
 - Exemptions for TCE in closed systems, holding TCE for distribution to 3rd party, licensed hospitals or academic medical facilities, research, development or experimental purposes, and processing for waste disposal
- **Replacement must be a chemical demonstrated to be less toxic to human health**
 - Still somewhat unclear which alternatives will be allowed
- **Sets aside \$250,000 in interest-free loans to research alternatives**

Minnesota TCE Alternatives Efforts

Goal:

- Decrease air emissions of TCE by working with Minnesota industries to minimize TCE use

Approach:

- Focus on replacing TCE with safer, yet effective options
- Overcome barriers for businesses seeking to switch away from TCE
- Avoid regrettable substitutions

Minnesota TCE Alternatives Project (EPA/MPCA funded)

- February 2019 – September 2020, extended to September 2021 for follow up only
- Goal: 4 companies, 10,000 lb TCE reduced
- Priority areas: Environmental Justice communities

Water Gremlin Supplemental Environmental Project (SEP)

- May 2019 - March 2022
- Goal: 6 TCE alternatives assessments at MN facilities
- Priority areas: within 40 miles of Water Gremlin



<https://www.turi.org/>



<http://www.mntap.umn.edu/>



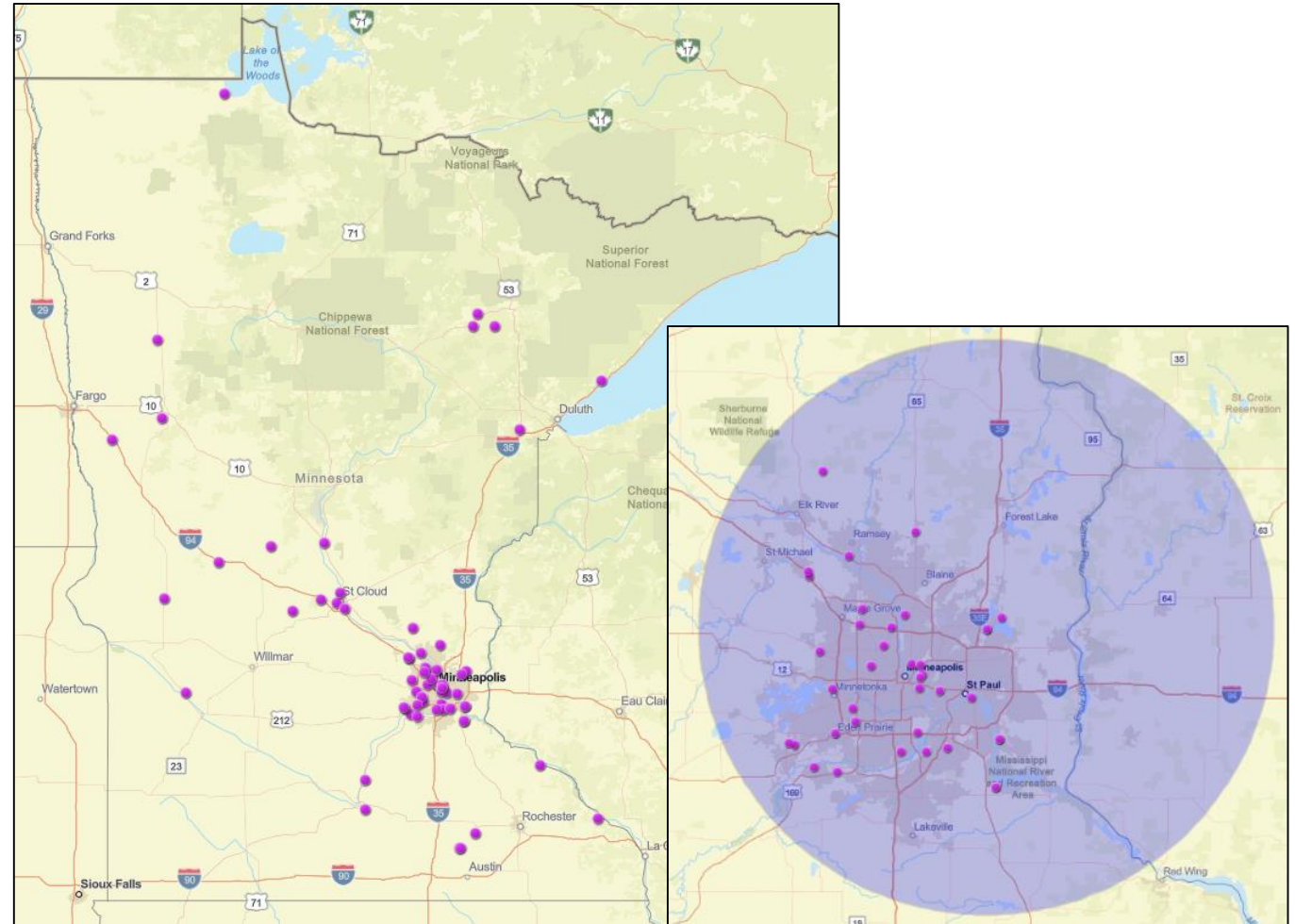
Project Status

- **9 companies currently participating**
 - 2 implementation in progress
 - 3 selecting equipment
 - 2 testing complete, evaluating options
 - 1 testing in progress
- **Participating companies represent over 300,000 lb/yr of TCE use**
- **3 additional companies declined to participate but are working on alternatives on their own**



Trichloroethylene (TCE) Use in Minnesota

- Primarily used for vapor degreasing, but there are other applications
- TCE is used in many locations throughout Minnesota
 - Large users
 - Small users
 - Commercial products
- Initially 122 potential TCE users identified
 - 15 confirmed users
 - 50 potential users remaining to be contacted or verified



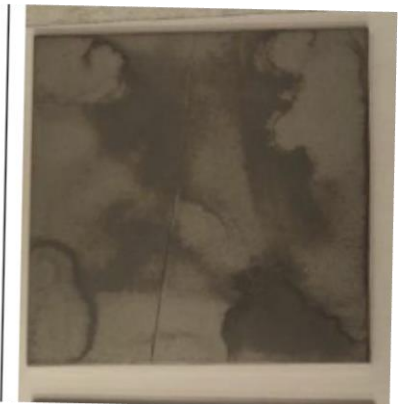
Steps in the TCE Alternatives Project

- Understand current process and cleaning needs:
 - Part geometry and materials
 - Soils to be removed
 - Level of cleaning required
- Collect samples for performance and solubility testing
- Identify cleaning products and methods that may meet process requirements
 - Equipment
 - Temperature
 - Ultrasonics/agitation
 - Rinsing/drying
- MnTAP provides technical assistance to support qualification and implementation of the selected alternative



TURI testing process

- Select potential cleaners using CleanerSolutions Database, and evaluates hazards using P2OASys
- The soils of interest are put onto coupons made from the same material as the parts
- Immersion testing
 - Unheated immersion
 - Heated immersion
 - Heated immersion with ultrasonics
- Removal of soils is assessed visually and gravimetrically
- Additional factors can be investigated if necessary
 - Temperature
 - Concentration
 - Time
 - Agitation
- Once promising processes have been identified, they are confirmed with real sample parts.



Current Work Horses of Cleaning

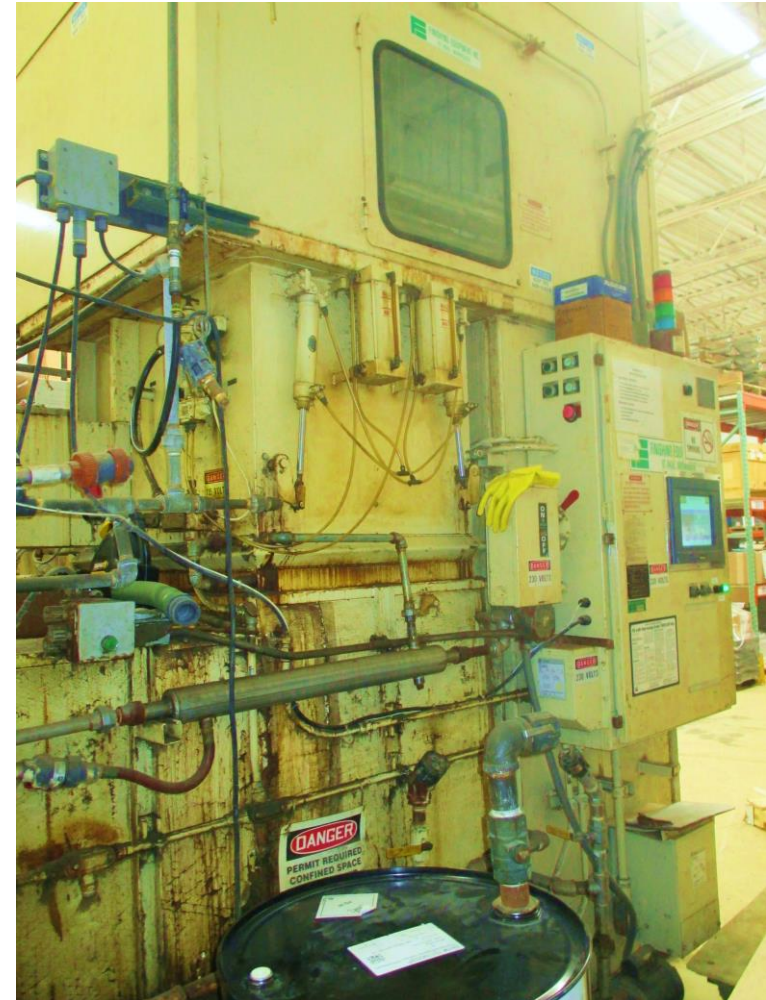
- **Trichloroethylene - TCE**
 - Commonly used in metal cleaning
 - Cancer and liver, and developmental health effects
- **n Propyl Bromide – nPB**
 - Often marketed as a safer replacement for TCE
 - Soon to be added to EPAs HAP list
 - Unreasonable developmental and cancer risks for solvent and cleaning use.
- **Perchloroethylene – PERC**
 - Used because of its non-flammability, high solvency, vapor pressure, and stability
 - Unreasonable risk due to neurotoxicity and cancer.
- **Trans-1,2-Dichloroethylene – tDCE**
 - Effective cleaning power
 - Risk evaluation in progress.
 - Requires mixture with fluorinated product
- **Hydrofluoroether – HFE**
 - Non-flammable
 - Breaks down into PFAS



But, they are all hazardous!

Obstacles to replacing TCE

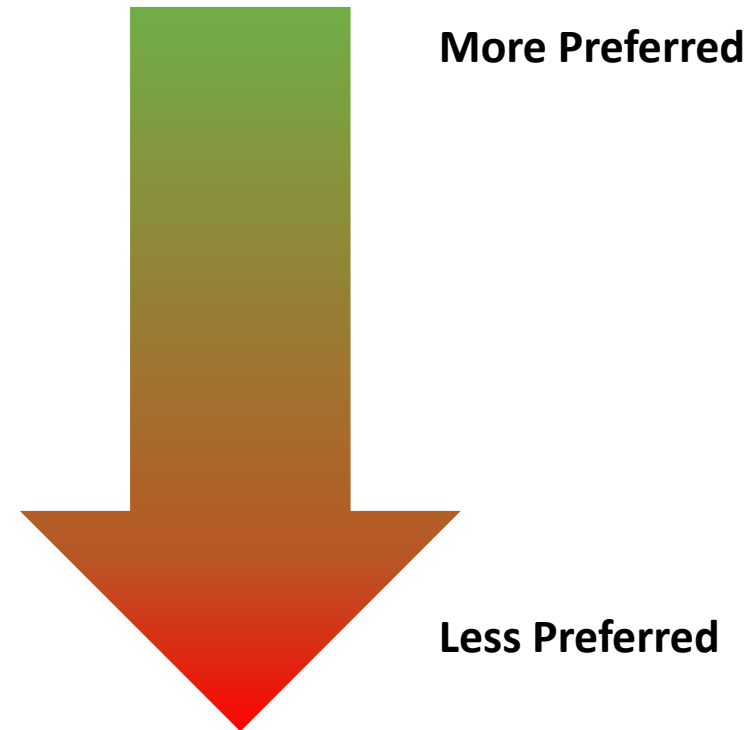
- **Getting reliable information**
 - What options might work in my process?
 - Are these really better?
 - Will they work long term?
- **Investment will be required**
 - Staff time – testing, administration
 - Capital – new equipment
 - Operational complexity - multiple operations
- **Impact to the business**
 - Employee re-training
 - Customer notification, requalification
 - Competition



TCE Alternatives, Source Reduction Perspective

What options do we have to replace TCE?

- None needed for application
- Solventless processes
- Aqueous systems
- Non-halogenated solvents
- Other halogenated solvents



P2OASys Tool

- Pollution Prevention Options Assessment System (P2OASys)
- Developed by TURI
- Helps companies **compare** the environmental, health and safety of various options
- 2 to 10 with the lower score being more desirable

| | Trichloro-ethylene | n Propyl Bromide (SG) | Trans-1,2-Dichloro-ethylene | Dowanol PnBGE | Dimethyl Glutarate | Liquinox | Ozzy Juice SW 3 |
|--------------------------------|--------------------|-----------------------|-----------------------------|---------------|--------------------|----------|-----------------|
| Acute Human Effects | 8 | 9 | 6 | 8 | 2 | 8 | 4 |
| Chronic Human Effects | 9 | 9 | 7 | 3 | 2 | 2 | 2 |
| Ecological Hazards | 8 | 8 | 5 | 2 | 3 | 8 | 5 |
| Environmental Fate & Transport | 9 | 10 | 8 | 4 | 8 | 5 | 7 |
| Atmospheric Hazard | 6 | 10 | 2 | 2 | 2 | 2 | 2 |
| Physical Properties | 10 | 10 | 10 | 6 | 5 | 5 | 5 |
| Process Factors | 7 | 9 | 6 | 8 | 4 | 5 | 4 |
| Life Cycle Factors | 10 | 10 | 8 | 4 | 3 | 7 | 4 |
| Weighted Average | 8.4 | 9.4 | 6.5 | 4.6 | 3.6 | 5.3 | 4.1 |

Recommended safer cleaners

- These products have been tested in the TCE Alternatives project.
- Effectiveness may vary depending on process needs
 - **Dowanol PnBGE** (glycol ether)
 - **Metalnox 6386** (modified alcohol)
 - **Dimethyl glutarate** (ester)
 - **Sta-Sol ESS 160** (dimethyl ester)
 - **OzzyJuice 3** (aqueous microbial)
 - **Alconox** (powder detergent)
 - **Liquinox** (alkaline aqueous)
 - **Micro 90** (alkaline aqueous)
 - **Buckeye International Immersion Cleaner** (alkaline aqueous)
 - **Aquavantage 1400 GD** (alkaline aqueous)
 - **SC Aircraft & Metal Cleaner** (alkaline aqueous)
 - **SC 1000** (alkaline aqueous)
 - **Soy Gold 2000** (soy based)

Cleaner costs

| Product | Primary Ingredient | \$/gal | Rec? | Equipment | Equipment Cost |
|--------------------------|--|-----------|------|---------------------|----------------------------|
| Trichloroethylene | | \$17 | no | vapor degreaser | NA |
| N-Propyl Bromide | | \$43 | no | vapor degreaser | minimal retrofitting |
| Fluosolv | 90% tDCE | \$80 | no | vapor degreaser | minimal retrofitting |
| Aerotron | >55% tDCE | \$91 | no | vapor degreaser | minimal retrofitting |
| Entron | >90% nPB | \$31 | no | vapor degreaser | minimal retrofitting |
| Novec 7100 | methyl nonafluoro-butyl/isobutyl ether | \$182 | no | vapor degreaser | minimal retrofitting |
| Dowanol PnBGE | >95% 1-Butoxy-2-propanol | \$93 | yes | immersion | \$300-\$6,000 |
| Metalnox 6386 | >90% 3-butoxypropan-2-ol | \$33 | yes | vacuum degreaser | \$400,000/ machine |
| Sta-Sol ESS 160 | dimethyl glutarate | | yes | immersion | \$300-\$6,000 |
| Aqueous cleaner | | \$12-\$20 | | immersion, spray | |
| Method dish soap | detergent | \$21 | yes | immersion | \$300-\$6,000 |
| aqueous phosphate system | EDTA/sodium phosphate | | yes | 2 stage clean/rinse | \$80,000 + water treatment |

*When changing from a vapor degreaser to a different cleaning process, the quantity of chemical needed may be significantly different, so comparing price per gallon may not tell the whole story.

Vapor Degreaser

- Most common method for cleaning with TCE
- Does not require rinsing or drying
- Varying levels of containment of solvent
- *No safe solvent options available*



Manual Cleaning

- Sink on a drum unit
- Compatible with aqueous cleaners
- Good for low volume applications
- Some systems include microbes that clean the solution, making it last longer
- \$100-\$3000+



Ultrasonic Cleaners

- Most commonly recommended for aqueous cleaning solutions, but can also be used with non-flammable solvents.
- Options for heat, rinses, automation
- Benchtop units \$80 - \$1,000+
- Larger units \$2,000 - \$100,000+



Spray cabinet

- Typically used with aqueous cleaning solutions
- Automated operation
- Small parts usually must be racked before cleaning
- \$2,500 - \$10,000+



Vacuum Degreaser

- Recommended for use with flammable solvents
- Totally enclosed system
- Vacuum Cycling Nucleation (VCN)- pulling a vacuum causes vapor bubbles on the part, especially in tight or porous areas, thoroughly cleaning part's internal areas. Cycling the vacuum causes dirty liquid to be pushed out and fresh liquid to flows back in to these internal areas.
- High cost - ~\$400,000/machine



Takeaways

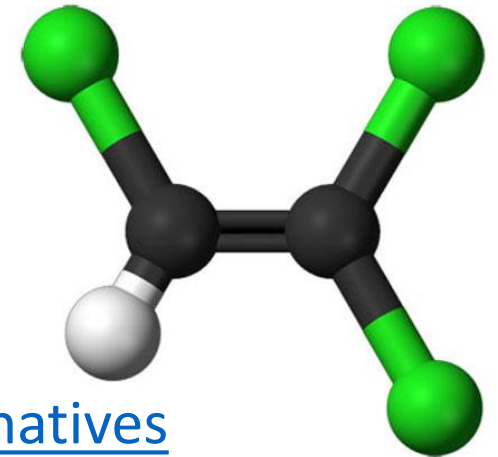
- **Although MN has now banned TCE, most large users were already engaged in the project.**
 - Negative publicity due to the Water Gremlin situation was the major driver for companies contacting MnTAP about TCE.
 - How to convey this sense of urgency to other areas without the need for a local crisis?
- **Pressure to act fast resulted in some companies following the path of least resistance leading to regrettable substitutions.**
 - Allowing time for facilities to explore options and do the necessary process development work may result in better outcomes.
 - Sometimes an interim step is needed while developing the long term solution.
- **Most companies will not find their way to truly safer alternatives on their own.**
 - Suppliers and equipment vendors promote regrettable substitutions that work in existing equipment.
 - Companies need help to make the larger process changes needed for safer options.



TCE Alternatives Training

- In partnership with TURI, provided training on strategies for TCE replacement
 - Held June 11, 2019 at University of Minnesota
 - 34 attendees from industry, technical assistance, and regulatory agencies
 - Recordings of training modules available on MnTAP website
 - MnTAP & the TCE Alternatives Project
 - TURI, Cleaning Background, & TCE Alternatives
 - TCE Case Studies
 - Site Visit Overview
 - CleanerSolutions and P2OASys Assessment Tools
 - Laboratory Testing Process & Implementation

<http://www.mntap.umn.edu/industries/facility/machine/tcealternatives>



TCE Alternatives Mini-Webinar series



- Series of eight mini-webinars, 2 - 4 minutes each
- Shared via email and social media June - August 2020
- Provide education and outreach on TCE use and alternatives
- Topics included:
 - Getting to Know TCE
 - Hazards of TCE
 - Policy
 - Where to Find TCE in Your Facility
 - Regrettable Substitutions
 - Case Studies
 - Financial Assistance
 - 10 Tips to Replace TCE
- The mini-webinars are available on the MnTAP web page at:
<http://www.mntap.umn.edu/industries/facility/machine/tcealternatives/webinar-and-training/>

Minnesota Technical Assistance Program

Strengthening Minnesota businesses by improving efficiency while saving money through energy, water, and waste prevention.

Questions?

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Thank You!